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Signed Stephen Hordley

Dated 14 April 2004

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Patents Form 1/77

Patents Act 1977
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01APR03 E796631 1 D00389
P01/7700 0.00-0307424.2

1/77

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

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Cardiff Road
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1. Your reference — P17501GB-LH/mf

2. Patent application number *(The Patent Office will fill in this part)* — 0307424.2 — 31 MAR 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

   Minebea Co. Ltd.,
   4106-73 Oaza Miyota,
   Miyota-machi, Kitasaku-gun,
   Nagano 389-0293,
   Japan.

   Patents ADP number *(if you know it)*

   If the applicant is a corporate body, give the country/state of its incorporation — Japan

4246831 006

4. Title of the invention — A Bearing Arrangement

5. Name of your agent *(if you have one)* — Forrester Ketley & Co.

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

   Forrester House
   52 Bounds Green Road
   London
   N11 2EY

   Patents ADP number *(if you know it)* — 133001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

   a) any applicant named in part 3 is not an inventor, or
   b) there is an inventor who is not named as an applicant, or
   c) any named applicant is a corporate body.
   See note (d))

   NO

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	-
Description	5
Claim *(s)*	2
Abstract	1
Drawing *(s)*	1

10. If you are also filing any of the following, state how many against each item.

Priority documents	NONE
Translations of priority documents	-
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	-
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	1
Any other documents *(please specify)*	-

11. I/We request the grant of a patent on the basis of this application.

Forrester Ketley & Co.

Signature: Forrester Ketley & Co.

Date: 31 March 2003

12. Name and daytime telephone number of person to contact in the United Kingdom: (020) 8889 6622 HOARTON, Lloyd

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.

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DUPLICATE

PATENTS ACT 1977

Agent's Ref: P17501GB-LH/mf

A BEARING ARRANGEMENT

This invention relates to a bearing arrangement and more particularly to high torque applications for spherical bearings.

Spherical bearings are often used in high torque applications where a pre-determined torque must be retained when a bearing is installed into a hole to provide a bearing function between two parts. Whilst it is preferred practice to have a degree of interference between the spherical bearing and the hole into which it is installed, the use of an interference fit hole causes the torque of the bearing to be increased considerably from its pre-installation torque, simply because the interference fit deforms the bearing housing effectively clamping the bearing housing down on to the ball. This is unfortunate because the more interference provided between the bearing and the hole, the more securely the bearing will be installed and held within the hole. Unfortunately, if the torque of the bearing arrangement in the interference hole is outside the tolerances specified for the application, the torque having been increased when inserted into the interference fit hole, then this arrangement can simply not be used. Accordingly, the conventional practice is to use a clearance fit hole into which the spherical bearing is inserted. The bearing housing is secured to the clearance fit hole by an adhesive. Figure 1 of the accompanying drawings shows a bearing arrangement in which a spherical bearing is installed in a clearance fit hole and secured therein by a layer of adhesive between the clearance fit hole and the outer surface of the bearing housing. This method ensures that the torque does not appreciably change during assembly so that the

measured torque of the bearing, prior to installation, remains substantially unaltered after installation.

However, it should be noted that the bearing is only as secure in the clearance fit hole as the strength of the adhesive allows. Typically, the adhesives used in these applications are brittle and their strength can reduce over time, leading to the possibility of movement between the bearing housing and the clearance fit hole as the adhesive layer degenerates. Typically, the clearance fit hole is located in an expensive or precision machined part of an overall apparatus and damage will be caused to the clearance fit hole and possibly other areas of the product as a result of movement of the bearing housing within the clearance fit hole. Thus, when the bearing needs replacing because it too may also be damaged because of its movement between the bearing housing and the clearance fit hole, the clearance fit hole is now oversize so the clearance fit hole needs to be re-bored - if that is possible - or the apparatus scrapped. In the case that the clearance fit hole can be re-bored, it would then be necessary to supply an oversize bearing housing - a one-off and expensive process.

It is an object of the present invention to provide a bearing arrangement which does not require the use of a clearance fit hole to maintain the torque of a bearing in an acceptable range after installation.

Accordingly, one aspect of the present invention provides a spherical bearing having a bearing housing and a ball located therein, the bearing housing having a rigid outer race, a rigid inner race and an annular elastomeric portion sandwiched between the races, wherein the outer race of the bearing housing is securely held in an interference fit hole.

In order that the present invention may be more readily understood, embodiments thereof will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic cross-section of a bearing arrangement not in accordance with the present invention installed in a clearance fit hole; and

Figure 2 is a bearing arrangement embodying the present invention installed in an interference fit hole.

Referring now to Figure 2 of the drawings, a bearing arrangement 1 embodying the present invention is shown and comprises a spherical bearing 2 having a bearing housing 3 and a ball 4 located therein, the bearing housing 2 having a rigid steel outer race 5 and a rigid steel inner race 6 between which is sandwiched an annular elastomeric portion7, in this example, a rubber sleeve bonded to both races 5,6. The outer race 5 of the bearing housing is securely held in an interference fit hole 8 (being an interference fit hole because the internal diameter of the hole 8 is less than the outer diameter of the outer race 5). It will be noted that there is no gap between the outer surface of the outer race 5 of the bearing housing 3 and the interference fit hole 8. This is in contrast to the conventional arrangement shown in Figure 1 in which a layer of adhesive 10 bonds the bearing housing to the clearance fit hole 11 - like numerals being used to denote like parts.

Preferably, a self-lubricating liner 12 is provided on the inner surface of the inner race 6 in contact with the ball 4. Alternatively, the inner race 6 and ball 4 may be in direct contact with one another.

If a conventional bearing such as that shown in Figure 1 were installed in an interference fit hole 8, then an increase in the torque between the ball 4 and the housing 3 would be observed. Increases in torque for low torque applications are not of great concern but for high torque applications where it is a requirement that torque be maintained with a predetermined range but at a high level, the use of an interference fit hole 8 dramatically increases the torque usually outside the acceptable range for that high torque application. This is because there is an almost exponential relationship between torque and the amount of interference at high torque (5 to 100Nm) applications. In some high torque applications (8 to 50Na), it is critical to maintain the high torque within a pre-determined range.

The spherical bearing 2 is installed in the interference fit hole 8 by heating the material defining the hole 8, typically a steel block to, for example, 200°C and by cooling the spherical bearing 2 by immersion in liquid nitrogen, typically -196°C, inserting the spherical bearing 2 into the interference fit hole 8 and allowing the temperatures of the two parts to return to ambient. Tests were undertaken to ascertain whether there had been an increase in oscillatory torque after installation but for torques ranging from 1Nm to 32Nm, there was no change whatsoever in the measured oscillatory torque after installation compared to that before installation. It seems that the use of an annular elastomeric portion 7 sandwiched between the two races 5,6 of the bearing housing 3 serves to absorb the interference which is not, therefore, transmitted to the interface between the ball 4 and the bearing housing 3.

An additional advantage of the bearing arrangement 1 using an interference fit hole for installation is that the bearing 2 is very securely held in

the interference fit hole 8 and requires a high axial load to remove it from the hole.

Interference fits in the range of 0.033mm to 0.198mm were used for bearings 2 having an outer diameter (i.e. the outer diameter of the outer race 5 of the bearing housing 3) of 66.736mm to 66.782mm. No increase in oscillatory torque values was noted after installation with these interference fits.

Not only does the interference fit installation of the spherical bearing 2 maintain torque within predetermined ranges in high torque applications but also the technique is far simpler than the adhesive method of assembly using a clearance fit hole which requires stringent cleanliness. Further, there is the advantage that of the risk of damage being caused to the installation hole by relative movement with the spherical bearing due to a breakdown of a securing adhesive between bearing 2 and clearance fit hole 11 is totally eliminated by the present invention.

In the present specification "comprises" means "includes or consists of" and "comprising" means "including or consisting of".

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS:

1. A bearing arrangement comprising a spherical bearing having a bearing housing and a ball located therein, the bearing housing having a rigid outer race and a rigid inner race and an annular elastomeric portion sandwiched between the races, wherein the outer race of the bearing housing is securely held in an interference fit hole.

2. A bearing arrangement according to Claim 1, wherein the spherical bearing is a high torque bearing having an oscillatory torque in the range of 5 to 100Nm prior to insertion in the interference fit hole.

3. A bearing arrangement according to Claim 2, wherein the spherical bearing is a high torque bearing having an oscillatory torque in the range of 8 to 50 Nm prior to insertion in the interference fit hole.

4. A bearing arrangement according to any preceding claim, wherein the elastomeric portion is bonded to the inner and outer races.

5. A bearing arrangement according to any preceding claim, wherein a liner is provided on the inner race in contact with the ball.

6. A bearing arrangement according to Claim 5, wherein the liner is a self-lubricating liner.

7. A bearing arrangement according to any one of Claims 1 to 4, wherein the inner race and ball are both manufactured from metal and the inner race is in direct contact with the ball.

8. A bearing arrangement substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

9. Any novel feature or combination of features disclosed herein.

ABSTRACT

A bearing arrangement comprising a spherical bearing having a bearing housing and a ball located therein, the bearing housing having a rigid outer race and a rigid inner race and an annular elastomeric portion sandwiched between the races, wherein the outer race of the bearing housing is securely held in an interference fit hole.

Figure 1

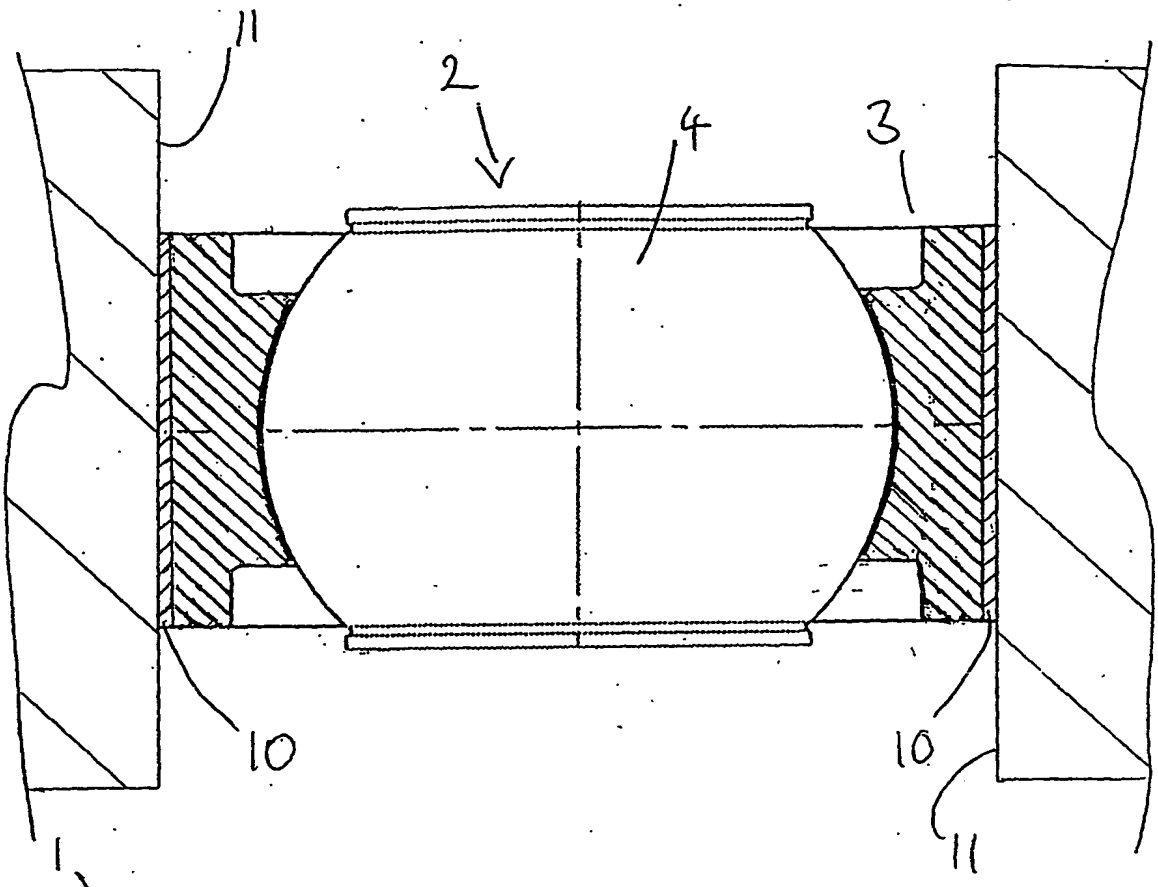
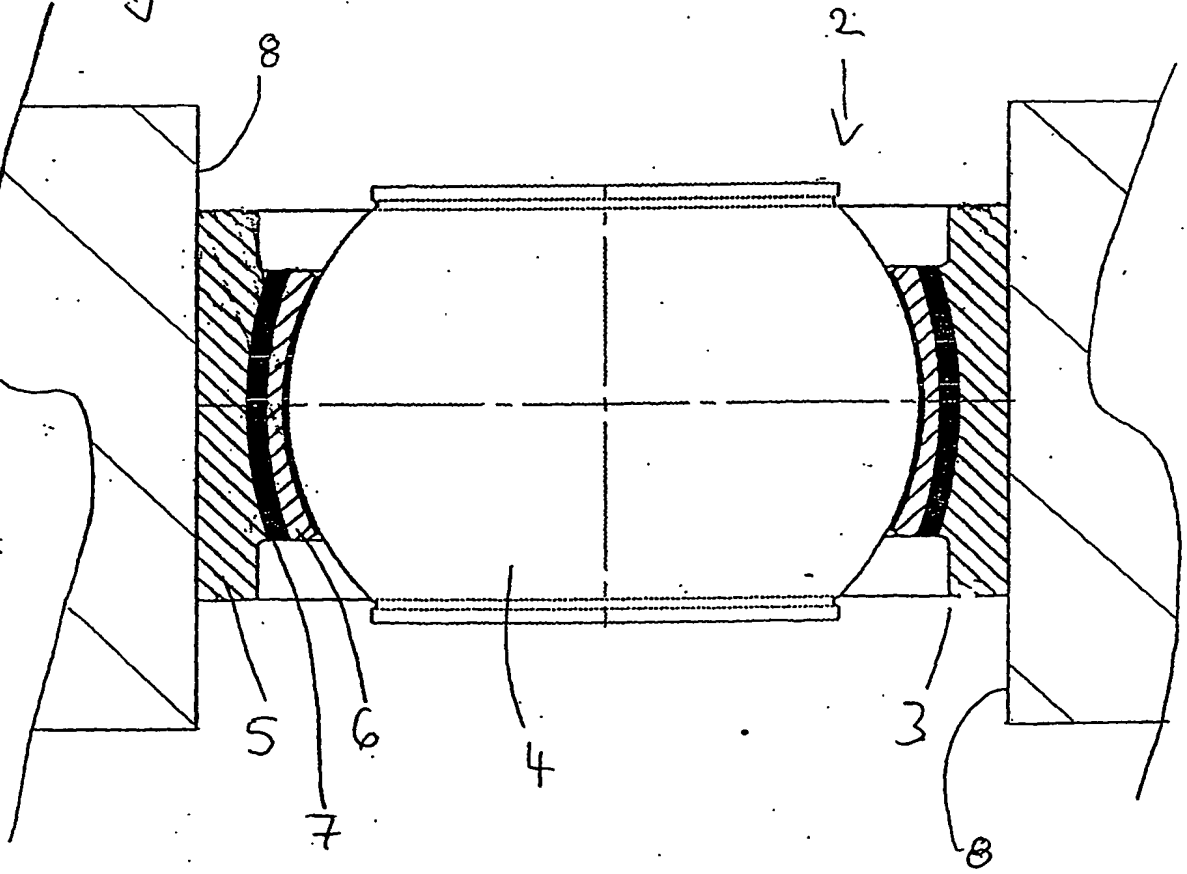


Figure 2



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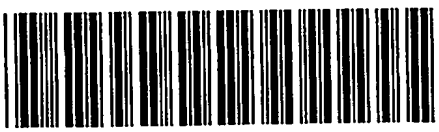

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